

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference P 98-298/NH	FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/SE 98/01741	International filing date (day/month/year) 29 Sept 1998	(Earliest) Priority Date (day/month/year) 30 Sept 1997
Applicant Asea Brown Boveri AB et al.		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 3 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. ☐ Certain claims were found unsearchable (See Box I).
2. ☐ Unity of invention is lacking (See Box II).
3. ☐ The international application contains disclosure of a nucleotide and/or amino acid sequence listing and the international search was carried out on the basis of the sequence listing
 - ☐ filed with the international application.
 - ☐ furnished by the applicant separately from the international application,
 - ☐ but not accompanied by a statement to the effect that it did not include matter going beyond the disclosure in the international application as filed.
 - ☐ transcribed by this Authority.
4. With regard to the title, ☒ the text is approved as submitted by the applicant.
☐ the text has been established by this Authority to read as follows:
5. With regard to the abstract,
 - ☒ the text is approved as submitted by the applicant.
 - ☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.
6. The figure of the drawings to be published with the abstract is:
 - Figure No. 2 ☒ as suggested by the applicant. ☐ None of the figures.
 - ☐ because the applicant failed to suggest a figure.
 - ☐ because this figure better characterizes the invention.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 98/01741

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H02K 19/26, H02K 19/36

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H02K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4785138 A (O. BREITENBACK ET AL.), 15 November 1988 (15.11.88), see the whole document --	1-18
Y	US 4121148 A (H. PLATZER), 17 October 1978 (17.10.78), see the whole document ✓ --	1-18
Y	US 4106069 A (J. TRAUTNER ET AL.), 8 August 1978 (08.08.78), see the whole document ✓ --	1-18
Y	DE 3009102 A1 (PROIZVOdstVENNOE OBEDINENIE URALELEKTROTJASCHMASCH IMENI V.I. LENINA), 25 Sept 1980 (25.09.80), see the whole document ✓ --	12-18

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

18 December 1998

Name and mailing address of the ISA/
Swedish Patent Office
Box 5055, S-102 42 STOCKHOLM
Facsimile No. +46 8 666 02 86

Date of mailing of the international search report

13 -01- 1999

Authorized officer

Lars Jakobsson
Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 98/01741

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5036165 A (R.K. ELTON ET AL.), 30 July 1991 (30.07.91), see the whole document -- ✓ -----	1-18

INTERNATIONAL SEARCH REPORT
Information on patent family members

01/12/98

International application No.

PCT/SE 98/01741

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4785138 A	15/11/88	DE 3543106 A,C	11/06/87
US 4121148 A	17/10/78	AT 340523 A,B	27/12/77
		DE 2714188 A,B,C	17/11/77
		FI 64871 B,C	30/09/83
		FI 771140 A	28/10/77
		FR 2349992 A,B	25/11/77
		GB 1541406 A	28/02/79
		NL 165615 B,C	17/11/80
		NL 7703629 A	31/10/77
		SE 423295 B,C	26/04/82
		SE 7704784 A	28/10/77
US 4106069 A	08/08/78	AT 265977 A	15/11/79
		AT 357216 B	25/06/80
		BR 7703213 A	08/02/78
		CA 1079349 A	10/06/80
		CH 615303 A	15/01/80
		DE 2622309 A,B,C	24/11/77
		GB 1542185 A	14/03/79
		IN 148531 A	28/03/81
		JP 1283918 C	27/09/85
		JP 52140812 A	24/11/77
		JP 60005155 B	08/02/85
		SE 430840 B,C	12/12/83
		SE 7705309 A	20/11/77
DE 3009102 A1	25/09/80	CH 653190 A,B	13/12/85
US 5036165 A	30/07/91	US 5066881 A	19/11/91
		US 5067046 A	19/11/91
		CA 1245270 A	22/11/88
		US 4853565 A	01/08/89

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

PCT

To:

L.A. Groth & Co. KB
Box 6107
102 32 STOCKHOLM

**NOTIFICATION OF TRANSMITTAL OF
INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

(PCT Rule 71.1)

Date of mailing
(day/month/year) 31-01-2000

Applicant's or agent's file reference
P 98-298/NH

IMPORTANT NOTIFICATION

International application No.
PCT/SE98/01741

International filing date (day/month/year)
29-09-1998

Priority date (day/month/year)
30-09-1997

Applicant
ABB AB
et al

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.
4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/
Patent- och registreringsverket
Box 5055
S-102 42 STOCKHOLM
Facsimile No. 08-887 72 88

Telex
17978
PATOREG-S

Authorized officer

Pia Danneberg

Telephone No. 08-782 25 00

PCT COOPERATION TREATY

PCT

NOTIFICATION OF THE RECORDING
OF A CHANGE(PCT Rule 92bis.1 and
Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

HOPFGARTEN, Nils
L.A. Groth & Co. KB
P.O. Box 6107
S-102 32 Stockholm
SUÈDE

Date of mailing (day/month/year) 21 September 1999 (21.09.99)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference P 98-298/NH	
International application No. PCT/SE98/01741	International filing date (day/month/year) 29 September 1998 (29.09.98)

1. The following indications appeared on record concerning: <input checked="" type="checkbox"/> the applicant <input type="checkbox"/> the inventor <input type="checkbox"/> the agent <input type="checkbox"/> the common representative		
Name and Address ASEA BROWN BOVERI AB S-721 83 Västerås Sweden	State of Nationality SE	State of Residence SE
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	
2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning: <input type="checkbox"/> the person <input checked="" type="checkbox"/> the name <input type="checkbox"/> the address <input type="checkbox"/> the nationality <input type="checkbox"/> the residence		
Name and Address ABB AB S-721 83 Västerås Sweden	State of Nationality SE	State of Residence SE
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	
3. Further observations, if necessary:		
4. A copy of this notification has been sent to: <input checked="" type="checkbox"/> the receiving Office <input type="checkbox"/> the designated Offices concerned <input type="checkbox"/> the International Searching Authority <input checked="" type="checkbox"/> the elected Offices concerned <input checked="" type="checkbox"/> the International Preliminary Examining Authority <input type="checkbox"/> other:		

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer Aino Metcalfe Telephone No.: (41-22) 338.83.38
---	---

PATENT COOPERATION TREATY

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

United States Patent and Trademark
Office
(Box PCT)
Crystal Plaza 2
Washington, DC 20231
ÉTATS-UNIS D'AMÉRIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 03 June 1999 (03.06.99)	
International application No. PCT/SE98/01741	Applicant's or agent's file reference P 98-298/NH
International filing date (day/month/year) 29 September 1998 (29.09.98)	Priority date (day/month/year) 30 September 1997 (30.09.97)
Applicant SÖRENSEN, Erland et al	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:

26 April 1999 (26.04.99)

☐ in a notice effecting later election filed with the International Bureau on:2. The election ☒ was☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

A. Karkachi

Telephone No.: (41-22) 338.83.38

PATENT COOPERATION TREATY

PCT

2000 -02- 02

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P 98-298 NH/uh	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/SE98/01741	International filing date (day/month/year) 29.09.1998	Priority date (day/month/year) 30.09.1997
International Patent Classification (IPC) or national classification and IPC ⁷ H02K 19/26, H02K 19/36		
Applicant ABB AB et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 4 sheets, including this cover sheet.
- ☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 3 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 26.04.1999	Date of completion of this report 27.01.2000
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 72 88 Telex 17978 PATOREG-S	Authorized officer Lars Jakobsson/AE Telephone No. 08-782 25 00

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/SE98/01741

I. Basis of the report

1. This report has been drawn on the basis of *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.)*:

☐ the international application as originally filed.

☒ the description, pages 1-7, as originally filed,
 pages _____, filed with the demand,
 pages _____, filed with the letter of _____,
 pages _____, filed with the letter of _____.

☒ the claims, Nos. _____, as originally filed,
 Nos. _____, as amended under Article 19,
 Nos. _____, filed with the demand,
 Nos. 1-18, filed with the letter of 27.12.1999,
 Nos. _____, filed with the letter of _____.

☒ the drawings, sheets/fig 1-3, as originally filed,
 sheets/fig _____, filed with the demand
 sheets/fig _____, filed with the letter of _____,
 sheets/fig _____, filed with the letter of _____.

2. The amendments have resulted in the cancellation of:

☐ the description, pages _____

☐ the claims, Nos. _____

☐ the drawings, sheets/fig _____

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the supplemental Box (Rule 70.2(c)).

4. Additional observations, if necessary:

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/SE998/01741

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	<u>1-18</u>	YES
	Claims		NO
Inventive step (IS)	Claims	<u>1-18</u>	YES
	Claims		NO
Industrial applicability (IA)	Claims	<u>1-18</u>	YES
	Claims		NO

2. Citations and explanations

The claimed invention relates to a rotary electric machine of alternating current type and intended for direct connection to a distribution or transmission network. According to the invention, the winding comprises at least one electric conductor, a first layer with semiconducting properties surrounding the conductor or each conductor, a solid insulating layer surrounds the first layer and a second layer with semiconducting properties surrounds the insulating layer. A brushless excitation system switchable between positive and negative excitation is arranged for excitation of the machine. The

claimed invention also relates to a machine comprising at least one rotary main electric machine of alternating current type provided with the winding and the brushless excitation system. The claimed invention also relates to a method of exciting a rotary electric machine.

Documents cited in the International Search Report:

US 4785138
US 4121148
US 4106069
DE 3009102
US 5036165

US 4785138 disclose an electric cable for use as a phase winding for a linear motor. The cable includes a conductive core surrounded by two conducting layers and an intermediate insulating layer. Additionally, the outer conductive layer is provided with a conductive sheathing.

.../...

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/SE98/01741

Supplemental Box

(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: Box V.

US 4121148, US 4106069 and DE 3009102 disclose brushless electrical machines.

US 5036165 disclose a cable comprising a conductive core surrounded by two semiconducting layers and an intermediate insulating layer. Even though it is suggested to apply a semiconducting layer to a winding in a dynamo-electric machine there is no specific indication of using the disclosed cable in a dynamo-electric machine. The semiconducting layer is intended to be used on a conventional winding in a machine or in a cable.

The claimed invention differs from the prior art in that a rotary electric machine is provided with a cable winding as specified and combined with a brushless excitation system, switchable between positive and negative excitation. The prior art's use of a cable as a phase winding for linear motors would not lead a skilled person to the invention since the conditions in rotating machines and linear machines present different type of problems. Furthermore, there is no teaching in the prior art indicating a possible use in rotating machines.

Accordingly, the claimed invention is novel and is considered to involve an inventive step. The invention is industrially applicable.

AMENDED CLAIMS

1. A rotary electric machine of alternating current type designed to be connected directly to a distribution or transmission network and comprising at
5 least one electric winding, **characterized** in that the winding comprises at least one electric conductor, a first layer with semiconducting properties surrounding the conductor, a solid insulating layer surrounding the first layer and a second layer with semiconducting properties surrounding the insulating layer, and also in that a brushless excitation system, switchable between positive and negative ex-
10 citation, is arranged for excitation of the machine.
2. A machine as claimed in claim 1, **characterized** in that the potential on the first layer is substantially equal to the potential on the conductor.
- 15 3. A machine as claimed in claim 1 or claim 2, **characterized** in that the second layer is arranged to form a substantially equipotential surface surrounding the conductor.
4. A machine as claimed in claim 3, **characterized** in that the second
20 layer is connected to a predetermined potential.
5. A machine as claimed in claim 4, **characterized** in that said predetermined potential is earth potential.
- 25 6. A machine as claimed in any of the preceding claims **characterized** in that at least two adjacent layers of the machine's winding have substantially equally large coefficients of thermal expansion.
7. A machine as claimed in any of the preceding claims **characterized** in
30 that the conductor comprises a number of strands, at least some of which are in electric contact with each other.
8. A machine as claimed in any of the preceding claims, **characterized** in that each of said three layers is firmly joined to adjacent layers along substantially
35 its entire contact surface.
9. A machine as claimed in any of the preceding claims, **characterized** in that said layers are arranged to adhere to each other even when the insulated conductor is bent.

10. A machine comprising at least one rotary main electric machine of alternating current type designed to be connected directly to a distribution or transmission network and comprising at least one magnetic core and at least one
5 electric winding, **characterized** in that the winding is formed from a cable comprising one or more current-carrying conductors, each conductor having a number of strands, an inner semiconducting layer arranged around each conductor, an insulating layer of solid insulating material arranged around said inner semiconducting layer, and an outer semiconducting layer arranged around the insulating
10 layer, and in that a brushless excitation system, switchable between positive and negative excitation, is arranged for excitation of the machine.

11. A machine as claimed in claim 10, **characterized** in that said cable comprises a metal screen or sheath.

15

12. A machine as claimed in any of the preceding claims, **characterized** in that the excitation system comprises two controllable antiparallel-connected current converter devices for feeding the field winding (4) of the alternating current machine, a two-way field over-voltage protection means (8, 10, 12, 14) or discharge circuit connected across the field winding, and control equipment for controlling current converters and field over-voltage protection means or discharge circuit.

13. A machine as claimed in claim 12, **characterized** in that for switching
25 the direction of the excitation current from the excitation system, the control equipment is arranged to change the polarity of the current converters, the control equipment causing the over-voltage protection means to be temporarily connected at transition from one to the other current direction.

30 14. A machine as claimed in claim 12 or claim 13 **characterized** in that the over-voltage protection means or the discharge circuit comprises a two-way thyristor discharge circuit (8, 10).

15. A machine as claimed in any of claims 12-14, **characterized** in that an
35 activated over-voltage protection means or discharge circuit can be reset by control of conducting converter devices (1, 2) to temporary or pulse-formed change of polarity.

16. A machine as claimed in any of claims 12-14, **characterized** in that an activated over-voltage protection means or discharge circuit can be reset by means of extinguishable semiconductor elements.
- 5 17. An electric power plant, **characterized** in that it comprises a rotary electric machine as claimed in any of claims 1-16.
18. A method of exciting a rotary electric machine as claimed in any of claims 1-16 with both positive and negative excitation current direction, **charac-**
10 **terized** in that a two-way field over-voltage protection means (8, 10, 12, 14) or a two-way discharge circuit is connected temporarily across the field winding (4) of the machine when switching between excitation current directions.
-

1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 99/00943

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H02J 3/36

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H02J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
D,A	WO 9745908 A1 (SIEMENS AKTIENGESELLSCHAFT), 4 December 1997 (04.12.97), figure 3, abstract	1-27
A	WO 9843336 A2 (ASEA BROWN BOVERI AB), 1 October 1998 (01.10.98), page 7, line 1 - line 10, figure 1	1-27
A	US 5499178 A (NED MOHAN), 12 March 1996 (12.03.96), column 13, line 5 - line 31, figure 8	1-27

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

- * Special categories of cited documents
- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "I" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search

Date of mailing of the international search report

16 February 2000

22-02-2000

Name and mailing address of the ISA/
Swedish Patent Office
Box 5055, S-102 42 STOCKHOLM
Facsimile No. +46 8 666 02 86

Authorized officer
Tomas Erlandsson/mj
Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/SE 99/00943

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9745908 A1	04/12/97	DE 19620906 A EP 0939995 A	08/01/98 08/09/99
WO 9843336 A2	01/10/98	AU 3468797 A CA 2218942 A EP 0909354 A SE 9701060 A SE 9703329 A US 5980095 A	21/01/98 24/09/98 21/04/99 04/03/98 25/09/98 09/11/99
US 5499178 A	12/03/96	WO 9418683 A EP 0617858 A JP 7502160 T US 5345375 A WO 9312576 A	18/08/94 05/10/94 02/03/95 06/09/94 24/06/93

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

17

Applicant's or agent's file reference P 98-298 NH/uh	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/SE98/01741	International filing date (day/month/year) 29.09.1998	Priority date (day/month/year) 30.09.1997
International Patent Classification (IPC) or national classification and IPC ₇ H02K 19/26, H02K 19/36		
Applicant ABB AB et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 3 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 26.04.1999	Date of completion of this report 27.01.2000
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 72 88	Authorized officer Lars Jakobsson/AE Telephone No. 08-782 25 00

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/SE98/01741

I. Basis of the report

1. This report has been drawn on the basis of *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.)*:

- ☐ the international application as originally filed.
- ☒ the description, pages 1 - 7, as originally filed,
 pages _____, filed with the demand,
 pages _____, filed with the letter of _____,
 pages _____, filed with the letter of _____.
- ☒ the claims, Nos. _____, as originally filed,
 Nos. _____, as amended under Article 19,
 Nos. _____, filed with the demand,
 Nos. 1 - 18, filed with the letter of 27.12.1999,
 Nos. _____, filed with the letter of _____.
- ☒ the drawings, sheets/fig 1 - 3, as originally filed,
 sheets/fig _____, filed with the demand
 sheets/fig _____, filed with the letter of _____,
 sheets/fig _____, filed with the letter of _____.

2. The amendments have resulted in the cancellation of:

- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheets/fig _____

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the supplemental Box (Rule 70.2(c)).

4. Additional observations, if necessary:

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/SE998/01741

V. Resoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	<u>1-18</u>	YES
	Claims		NO
Inventive step (IS)	Claims	<u>1-18</u>	YES
	Claims		NO
Industrial applicability (IA)	Claims	<u>1-18</u>	YES
	Claims		NO

2. Citations and explanations

The claimed invention relates to a rotary electric machine of alternating current type and intended for direct connection to a distribution or transmission network. According to the invention, the winding comprises at least one electric conductor, a first layer with semiconducting properties surrounding the conductor or each conductor, a solid insulating layer surrounds the first layer and a second layer with semiconducting properties surrounds the insulating layer. A brushless excitation system switchable between positive and negative excitation is arranged for excitation of the machine.

The claimed invention also relates to a machine comprising at least one rotary main electric machine of alternating current type provided with the winding and the brushless excitation system. The claimed invention also relates to a method of exciting a rotary electric machine.

Documents cited in the International Search Report:

US 4785138
US 4121148
US 4106069
DE 3009102
US 5036165

US 4785138 disclose an electric cable for use as a phase winding for a linear motor. The cable includes a conductive core surrounded by two conducting layers and an intermediate insulating layer. Additionally, the outer conductive layer is provided with a conductive sheathing.

.../...

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/SE98/01741

Supplemental Box

(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: Box V.

US 4121148, US 4106069 and DE 3009102 disclose brushless electrical machines.

US 5036165 disclose a cable comprising a conductive core surrounded by two semiconducting layers and an intermediate insulating layer. Even though it is suggested to apply a semiconducting layer to a winding in a dynamo-electric machine there is no specific indication of using the disclosed cable in a dynamo-electric machine. The semiconducting layer is intended to be used on a conventional winding in a machine or in a cable.

The claimed invention differs from the prior art in that a rotary electric machine is provided with a cable winding as specified and combined with a brushless excitation system, switchable between positive and negative excitation. The prior art's use of a cable as a phase winding for linear motors would not lead a skilled person to the invention since the conditions in rotating machines and linear machines present different type of problems. Furthermore, there is no teaching in the prior art indicating a possible use in rotating machines.

Accordingly, the claimed invention is novel and is considered to involve an inventive step. The invention is industrially applicable.

CLAIMS

1. A rotary electric machine of alternating current type designed to be connected directly to a distribution or transmission network and comprising at
5 least one electric winding, **characterized** in that the winding comprises at least one electric conductor, a first layer with semiconducting properties surrounding the conductor, a solid insulating layer surrounding the first layer and a second layer with semiconducting properties surrounding the insulating layer, and also in that a brushless excitation system, switchable between positive and negative exci-
10 tation, is arranged for excitation of the machine.
2. A machine as claimed in claim 1, **characterized** in that the potential on the first layer is substantially equal to the potential on the conductor.
- 15 3. A machine as claimed in claim 1 or claim 2, **characterized** in that the second layer is arranged to form a substantially equipotential surface surrounding the conductor.
4. A machine as claimed in claim 3, **characterized** in that the second
20 layer is connected to a predetermined potential.
5. A machine as claimed in claim 4, **characterized** in that said predetermined potential is earth potential.
- 25 6. A machine as claimed in any of the preceding claims **characterized** in that at least two adjacent layers of the machine's winding have substantially equally large coefficients of thermal expansion.
7. A machine as claimed in any of the preceding claims **characterized** in
30 that the conductor comprises a number of strands, at least some of which are in electric contact with each other.
8. A machine as claimed in any of the preceding claims, **characterized** in that each of said three layers is firmly joined to adjacent layers along substantially
35 its entire contact surface.
9. A machine as claimed in any of the preceding claims, **characterized** in that said layers are arranged to adhere to each other even when the insulated conductor is bent.

10. A machine comprising at least one main electric machine of alternating current type designed to be connected directly to a distribution or transmission network and comprising at least one magnetic core and at least one electric winding, **characterized** in that the winding is formed from a cable comprising one or more current-carrying conductors, each conductor having a number of strands, an inner semiconducting layer arranged around each conductor, an insulating layer of solid insulating material arranged around said inner semiconducting layer, and an outer semiconducting layer arranged around the insulating layer, and in that a brushless excitation system, switchable between positive and negative excitation, is arranged for excitation of the machine.

11. A machine as claimed in claim 10, **characterized** in that said cable comprises a metal screen or sheath.

12. A machine as claimed in any of the preceding claims, **characterized** in that the excitation system comprises two controllable antiparallel-connected current converter devices for feeding the field winding (4) of the alternating current machine, a two-way field over-voltage protection means (8, 10, 12, 14) or discharge circuit connected across the field winding, and control equipment for controlling current converters and field over-voltage protection means or discharge circuit.

13. A machine as claimed in claim 12, **characterized** in that for switching the direction of the excitation current from the excitation system, the control equipment is arranged to change the polarity of the current converters, the control equipment causing the over-voltage protection means to be temporarily connected at transition from one to the other current direction.

14. A machine as claimed in claim 12 or claim 13 **characterized** in that the over-voltage protection means or the discharge circuit comprises a two-way thyristor discharge circuit (8, 10).

15. A machine as claimed in any of claims 12-14, **characterized** in that an activated over-voltage protection means or discharge circuit can be reset by control of conducting converter devices (1, 2) to temporary or pulse-formed change of polarity.

16. A machine as claimed in any of claims 12-14, **characterized** in that an activated over-voltage protection means or discharge circuit can be reset by means of extinguishable semiconductor elements.
- 5 17. An electric power plant, **characterized** in that it comprises a rotary electric machine as claimed in any of claims 1-16.
18. A method of exciting a rotary electric machine with both positive and negative excitation current direction, **characterized** in that a two-way field over-
10 voltage protection means (8, 10, 12, 14) or a two-way discharge circuit is connected temporarily across the field winding (4) of the machine when switching between excitation current directions.
-

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REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

International Application No. PCT/ SE 98 / 01741

International Filing Date

29 -09- 1998

The Swedish Patent Office
PCT International Application

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference
(if desired) (12 characters maximum)

P 98-298/NH

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RO,
[initials]

Box No. I TITLE OF INVENTION

A ROTARY ELECTRIC MACHINE

Box No. II APPLICANT

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

Asea Brown Boveri AB

S-721 83 VÄSTERÅS
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☐ This person is also inventor.

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Facsimile No.

Teleprinter No.

State (that is, country) of nationality:

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This person is applicant for the purposes of:

☐ all designated States

☒ all designated States except the United States of America

☐ the United States of America only

☐ the States indicated in the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

SÖRENSEN, Erland
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S-723 55 VÄSTERÅS
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This person is:

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☒ applicant and inventor

☐ inventor only (If this check-box is marked, do not fill in below.)

State (that is, country) of nationality:

SE

State (that is, country) of residence:

SE

This person is applicant for the purposes of:

☐ all designated States

☐ all designated States except the United States of America

☒ the United States of America only

☐ the States indicated in the Supplemental Box

☒ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:

☒ agent

☐ common representative

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

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Facsimile No.

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Teleprinter No.

☐ Address for correspondence: Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

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RO/SE

Continuation of Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

If none of the following sub-boxes is used, this sheet should not be included in the request.

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

LEIJON, Mats
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S-723 35 VÄSTERÅS

Sweden

This person is:

- ☐ applicant only
☒ applicant and inventor
☐ inventor only (If this check-box is marked, do not fill in below.)

State (that is, country) of nationality:

SE

State (that is, country) of residence:

SE

This person is applicant for the purposes of:

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Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

This person is:

- ☐ applicant only
☐ applicant and inventor
☐ inventor only (If this check-box is marked, do not fill in below.)

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This person is:

- ☐ applicant only
☐ applicant and inventor
☐ inventor only (If this check-box is marked, do not fill in below.)

State (that is, country) of nationality:

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Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

This person is:

- ☐ applicant only
☐ applicant and inventor
☐ inventor only (If this check-box is marked, do not fill in below.)

State (that is, country) of nationality:

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Box No.V DESIGNATION STATES

The following designations are hereby made under Rule 4.9(a) (mark the applicable check-boxes; at least one must be marked).

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| <input checked="" type="checkbox"/> BG Bulgaria | |
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| <input checked="" type="checkbox"/> CU Cuba | <input checked="" type="checkbox"/> PL Poland |
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| | <input checked="" type="checkbox"/> ZW Zimbabwe |
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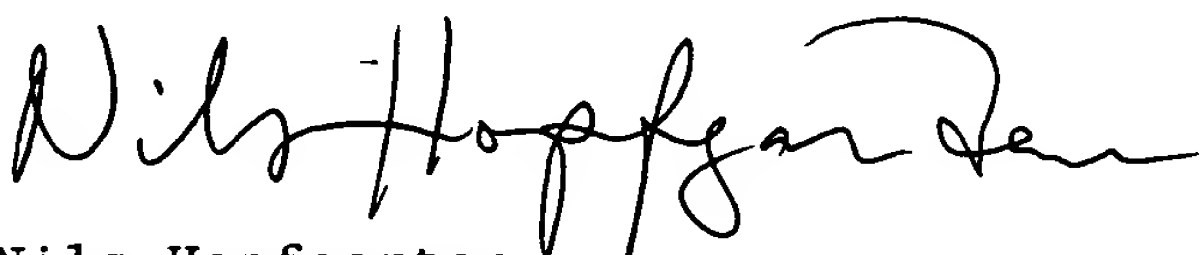
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29 -09- 1998

Sheet No. 4

Box No. VI PRIORITY CLAIM					<input type="checkbox"/> Further priority claims are indicated in the Supplemental Box.				
Filing date of earlier application (day/month/year)		Number of earlier application	Where earlier application is:						
			national application: country	regional application:* regional Office	international application: receiving Office				
item (1) 30 Septemb. 1997 (30.09.1997)		9703555-4	Sweden						
item (2)									
item (3)									
<input checked="" type="checkbox"/> The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) (only if the earlier application was filed with the Office which for the purposes of the present international application is the receiving Office) identified above as item(s): (1)									
<small>* Where the earlier application is an ARIPO application, it is mandatory to indicate in the Supplemental Box at least one country party to the Paris Convention for the Protection of Industrial Property for which that earlier application was filed (Rule 4.10(b)(ii)). See Supplemental Box.</small>									
Box No. VII INTERNATIONAL SEARCHING AUTHORITY									
Choice of International Searching Authority (ISA) <small>(if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):</small>			Request to use results of earlier search; reference to that search (if an earlier search has been carried out by or requested from the International Searching Authority):						
ISA / SE			Date (day/month/year) Number Country (or regional Office) 30 September 1997 SE 97/01160 Sweden						
Box No. VIII CHECK LIST; LANGUAGE OF FILING									
This international application contains the following number of sheet: request : 4 description (excluding sequence listing part) : 7 claims : 3 abstract : 1 drawings : 4✓ sequence listing part of description : -- Total number of sheets : 19✓			This international application is accompanied by the item(s) marked below: 1. <input type="checkbox"/> fee calculation sheet 2. <input type="checkbox"/> separate signed power of attorney 3. <input type="checkbox"/> copy of general power of attorney; reference number, if any: 4. <input type="checkbox"/> statement explaining lack of signature 5. <input type="checkbox"/> priority document(s) identified in Box No. VI as item(s): 6. <input type="checkbox"/> translation of international application into (language): 7. <input type="checkbox"/> separate indications concerning deposited microorganism or other biological material 8. <input type="checkbox"/> nucleotide and/or amino acid sequence listing in computer readable form 9. <input checked="" type="checkbox"/> other (specify): Copy of Off.Action + ITS report						
Figure of the drawings which should accompany the abstract: 2			Language of filing of the international application: Swedish						
Box No. IX SIGNATURE OF APPLICANT OR AGENT									
Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).									
L.A.GROTH & Co.KB  Nils Hopfgarten									

For receiving Office use only			
1. Date of actual receipt of the purported international application:	29 -09- 1998		
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:			
4. Date of timely receipt of the required corrections under PCT Article 11(2):			
5. International Searching Authority (if two or more are competent): ISA / SE	6. <input type="checkbox"/> Transmittal of search copy delayed until search fee is paid.		
2. Drawings:		<input checked="" type="checkbox"/> received: <input type="checkbox"/> not received:	

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Date of receipt of the record copy by the International Bureau:	16 OCTOBER 1998 (16.10.98)

ROTERANDE ELEKTRISK MASKIN

Tekniskt område

Föreliggande uppfinning avser en roterande elektrisk maskin av växel-
5 strömstyp, avsedd att anslutas direkt till ett distributions- eller transmissionsnät och innefattande minst en elektrisk lindning. Uppfinningen avser också en elkraftanläggning innefattande en sådan elektrisk maskin samt ett förfarande för magnetisering av en roterande elektrisk maskin.

10 Uppfinningens bakgrund

Den roterande elektriska maskinen enligt uppfinningen kan vara t.ex. en synkronmaskin, dubbelmatad maskin, ytterpolmaskin eller synkronflödesmaskin.

För att ansluta maskiner av detta slag till distributions- eller transmissionsnät, i det följande gemensamt kallade kraftnät, har hittills transformatorer använts
15 för upptransformering av spänningen till nätnivå, dvs. till området 130 - 400 kV.

Generatorer med en märkspänning av upp till 36 kV är beskrivna av Paul R. Siedler "36 kV Generators Arise from Insulation Research", Electrical World, 5 October 1932, sid. 524-527. Dessa generatorer innefattar lindningar av högspänningskabel, varvid isoleringen är uppdelad i olika skikt med olika dielektricitetskonstanter. Det använda isoleringsmaterialet består av olika kombinationer av de tre
20 komponenterna glimmerbladglimmer, lack och papper.

Det har nu visat sig att, genom att framställa den inledningsvis omvända lindningen hos den elektriska maskinen av en isolerad elektrisk högspänningsledare med en fast isolation av liknande slag som hos kablar för kraftöverföring kan maski-
25 nens spänning höjas till sådana nivåer att maskinen kan direkt anslutas till vilket kraftnät som helst utan mellanliggande transformatorer. Typiskt driftsområde för dessa maskiner är 30-800 kV.

I dagens läge används statiska matare eller borstlösa matare med roterande diodlikriktarbryggor i roterande elektriska maskiner. Ofta förekommande krav
30 på magnetiseringsutrustningen är att den skall kunna producera en toppspänning, och toppström, som är 1,5 till 3 gånger så stor som motsvarande storheter vid märklastmagnetisering för maskinen i fråga under 10 - 30 sekunder. Vidare skall magnetiseringsutrustningen kunna producera en fältström motsvarande märklastmagnetiseringsströmmen vid 25 % spänning på maskinens statoruttag. Magnetise-

ringssystemet skall företrädesvis vara "underhållsfritt", dvs. ett magnetiseringssystem utan släpringar. Vidare skall svars- och insvängningstider vid nätstörningar vara snabba, dvs. magnetiseringsutrustningen skall kunna alstra såväl positiv som negativ fältspänning. För synkronkompensatorer tillkommer normalt att magnetiseringssystemet skall kunna producera såväl positiv som negativ fältström och behov av toppspänningsfaktorer större än 3 gånger märklstmagnetiseringsspänningen kan förekomma.

Med borstlösa matare eliminerar man sålunda problemen med nedsmutsning med koldamm från borstar och släpringar medan borstlösa matare enligt hittills
10 känd teknik uppvisar sämre reglerprestanda än statiska matare.

Syftet med föreliggande uppfinning är sålunda att åstadkomma en roterande elektrisk maskin, som kan anslutas direkt till kraftnät och som är försedd med ett "underhållsfritt" magnetiseringssystem med förbättrade reglerprestanda, och en elkraftanläggning innefattande en sådan elektrisk maskin, samt att föreslå ett förfarande för magnetisering av en roterande elektrisk maskin.
15

Redogörelse för uppfinningen

Detta syfte uppnås med en roterande elektrisk maskin av inledningsvis angivet slag med i patentkravet 1 angivna kännetecken, en elkraftanläggning enligt patentkravet
20 17 och ett förfarande enligt patentkravet 18.

Den isolerade ledaren eller högspänningskabeln som används vid föreliggande uppfinning är flexibel och böjlig och av det slag som närmare beskrivs i WO 97/45919 och WO 97/45847. Ytterligare beskrivning av den isolerade ledaren eller kabeln finns i WO 97/45918, WO 97/45930 och WO 97/45931.

25 Således är, vid anordningen enligt uppfinningen, lindningarna företrädesvis av ett slag motsvarande kablar med fast extruderad isolation som i dag används för kraftdistribution, t.ex. s.k. PEX-kablar eller kablar med EPR-isolation. En sådan innefattar en inre ledare sammansatt av en eller flera kardeler, ett ledaren omgivande inre halvledande skikt, ett detta omgivande fast isoleringsskikt och ett isoleringsskikt
30 omgivande yttre halvledande skikt. Dylika kablar är böjliga vilket är en väsentlig egenskap i sammanhanget eftersom tekniken för anordningen enligt uppfinningen i första hand baserar sig på ett lindningssystem där lindningen görs med ledningar som böjs vid montering. En PEX-kabel har normalt en böjlighet motsvarande en

krökningsradie på ca 20 cm för en kabel med 30 mm diameter och en krökningsradie på ca 65 cm för en kabel med 80 mm diameter. Med uttrycket böjlig avses i denna ansökan således att lindningen är böjlig ned till en krökningsradie i storleksordningen 4 gånger kabeldiametern och företrädesvis 8-12 gånger kabeldiametern.

- 5 Lindningen bör vara utförd så att den kan bibehålla sina egenskaper även när den böjs och när den under drift utsättes för termiska eller mekaniska påkänningar. Att skikten bibehåller sin vidhäftning vid varandra är av stor betydelse i detta sammanhang. Avgörande är här skiktens materialegenskaper, framför allt deras elasticitet och deras relativa värmeutvidgningskoefficienter. För exempelvis en PEX-
- 10 kabel är det isolerande skiktet av tvärbunden lågdensitetspolyeten och de halvledande skikten av polyeten med inblandade sot- och metallpartiklar. Volymförändringar till följd av temperaturförändringar upptas helt som radieförändringar i kabeln och tack vare den jämförelsevis ringa skillnaden hos skiktens värmeutvidgningskoefficienter i förhållande till den elasticitet som dessa material har, så kommer kabelns radiella expansion att kunna ske utan att skikten lossnar från varandra.
- 15

Ovan angivna materialkombinationer är endast att ses som exempel. Inom uppfinningens ram faller naturligtvis även andra kombinationer som uppfyller de nämnda villkoren och uppfyller villkoren att vara halvledande, dvs. med en resistivitet i området 10^{-1} - 10^6 ohm-cm, t. ex. 1 - 500 ohm-cm, eller 10 - 200 ohm-cm.

- 20 Det isolerande skiktet kan exempelvis utgöras av ett fast termoplastiskt material såsom lågdensitetspolyeten (LDPE), högdensitetspolyeten (HDPE), polypropylen (PP), polybutylen (PB), polymetylpenten (PMP), tvärbundna material såsom tvärbunden polyetylen (XLPE eller PEX) eller gummi såsom etylenpropylen-gummi (EPR) eller silikongummi.

- 25 De inre och yttre halvledande skikten kan ha samma basmaterial men med inblandning av partiklar av ledande material såsom sot eller metallpulver.

- De mekaniska egenskaperna hos dessa material, framför allt deras värmeutvidgningskoefficienter, påverkas ganska ringa av om det är inblandat med sot eller metallpulver eller ej, dvs i de proportioner som erfordras för att uppnå den enligt
- 30 uppfinningen erforderliga ledningsförmågan. Det isolerande skiktet och de halvledande skikten får därmed i stort sett samma värmeutvidgningskoefficienter.

För de halvledande skikten kan även etylenvinyl-acetatsampolymer/nitrilgummi, butylmppolyeten, etylen-akrylat-sampolymer och etylenetylakrylat-sampolymer utgöra lämpliga polymerer.

Även då olika slag av material användes som bas i respektive skikt är det
5 önskvärt att deras värmeutvidgningskoefficient är av samma storleksordning. För kombinationen av de ovan uppräknade materialen förhåller det sig på detta sätt.

De ovan uppräknade materialen har en ganska god elasticitet med en E-modul $E < 500 \text{ MPa}$, företrädesvis $< 200 \text{ MPa}$. Elasticiteten är tillräcklig för att
10 eventuella smärre avvikelser hos värmeutvidgningskoefficienterna för materialen i skikten kommer att upptas i radialriktningen av elasticiteten så att ej sprickor eller andra skador uppstår och så att skikten ej släpper från varandra. Materialet i skikten är elastiska och vidhäftningen mellan skikten av åtminstone samma storleksordning som i det svagaste av materialen.

Ledningsförmågan hos de båda halvledande skikten är tillräckligt stor för att
15 i huvudsak utjämna potentialen längs respektive skikt. Ledningsförmågan hos det yttre halvledande skiktet är så pass stor att det yttre halvledande skiktet har tillräcklig ledningsförmåga för att innesluta det elektriska fältet i kabeln, men samtidigt liten nog att ej ge anledning till signifikanta förluster p g a i skiktets längsriktning inducerade strömmar.

20 Vardera av de båda halvledande skikten utgör således väsentligen en ekvipotentialyta och lindningen med dessa skikt kommer att i huvudsak innesluta det elektriska fältet inom sig.

Det utesluts naturligtvis inte att ytterligare ett eller flera halvledande skikt kan vara anordnade i det isolerande skiktet.

25 Genom att förse den elektriska maskinen ifråga med ett borstlöst, mellan positiv och negativ magnetisering växlingsbart magnetiseringssystem får den ett "underhållsfritt" system med snabba svars- och insvängningstider vid exempelvis nätstörningar genom att magnetiseringssystemet kan producera såväl positiv som negativ fältspänning och därmed positiv och negativ fältström.

30 Enligt en fördelaktig utföringsform av maskinen enligt uppfinningen innefattar magnetiseringssystemet två styrbara, antiparallellkopplade strömriktaranordningar för matning av växelströmsmaskinens fältlindningen, ett dubbelriktat fältöverspänningsskydd eller urladdningskrets inkopplad över fältlindningen samt styr-

utrustning för styrning av strömriktare och överspänningsskydd eller urladdningskrets. Detta är ett enkelt utförande som ej kräver galvaniskt separerade matningskällor och strömbegränsande reaktanser och ej heller separata kortslutningsdon för släckning och av ledande tyristorer. Magnetiseringssystemet är även väl lämpat för synkronmaskiner av typen synkronkompensatorer. I denna uppfinning utnyttjas sålunda halvledarteknikens möjligheter till temporär polaritetsändring på enkelt sätt, vilket underlättar snabb kommutering av fältströmmen från strömriktarbrygga till kortslutningskrets och vice versa vid behov av ändrad strömriktning i maskinens fältkrets.

10

Kort beskrivning av ritningarna

För att förklara uppfinningen närmare kommer nu såsom exempel valda utföringsformer av maskinen enligt uppfinningen att beskrivas mera i detalj med hänvisning till bifogde ritningar, på vilka

15 figur 1 visar den isolerade ledare som används i maskinen enligt uppfinningen,

fig 2 visar ett schema över magnetiseringssystemet vid maskinen enligt uppfinningen, och

fig. 3a-f visar spännings- och strömförlopp vid bryggväxling vid magnetiseringssystemet i fig. 2.

20

Beskrivning av en föredragen utföringsform

I figur 1 visas en tvärsnittsvy av isolerad ledare 11, avsedd att användas i lindningarna vid maskinen enligt föreliggande uppfinning.

Den isolerade ledaren 11 innefattar sålunda ett antal kardeler 35 med cirkulärt tvärsnitt av exempelvis koppar (Cu). Dessa kardeler 35 är anordnade i mitten av den isolerade ledaren 11. Runt kardelerna 35 är anordnat ett första halvledande skikt 13. Runt det första halvledande skiktet 13 finns anordnat ett isolationsskikt 37, t.ex. PEX-isolation. Runt isolationsskiktet 37 finns anordnat ett andra halvledande skikt 15. Den isolerade ledaren är böjlig och bibehåller denna egenskap under sin livslängd. Nämnade tre skikt är utförda så att de vidhäftar varandra även då den isolerade ledaren böjs. Den isolerade ledaren har en diameter i intervallet 20 - 250 mm och en ledningsarea i intervallet 80 - 3000 mm².

30

I figur 2 visas ett schema över magnetiseringssystemet i maskinen enligt uppfinningen. Maskinens fältlindning 4, vilken kan vara stationär eller roterande är förbunden med två antiparallellkopplade strömriktarbryggor 1, 2. Över fältlindningen 4 är vidare ett dubbelriktat överspänningsskydd, innefattande två antiparallellkopplade tyristorer 8, 10 med tillhörande tändkretsar 12, 14.

Strömriktarbryggorna 1,2 matas från en matningskälla, vid 16 och styrs från en omkopplingslogik 18 via styripulsförstärkare 20, 22. En styripulsgenerator 28 för de såsom tyristorbryggor utformade strömriktarbryggorna 1,2 är likaledes anordnad att avge styripulser till pulsförstärkarna 20, 22. Mätidon 24, 26 är vidare anordnade att mäta strömmarna I_{FB1} respektive I_{FB2} från strömriktarbryggorna 1 respektive 2 och överföra mätresultaten till omkopplingslogiken 18 för styrändamål. Även inkopplingen av överspänningsskyddets tyristorer 8, 10 styrs från omkopplingslogiken 18 via tändkretsarna 12, 14. Överspänningsskyddet är anslutet till ett strömbegränsningsmotstånd R. Vid systemet med fältbrytare tjänar detta motstånd R som urladdningsmotstånd.

Förfarandet vid bryggväxling från bryggan 1 till bryggan 2 är följande. I utgångsläget antas brygga 1 vara ledande, vilket innebär positiv strömriktning I_F genom fältlindningen 4, jfr. fig. 3a och b. Styrsignalen U_{st}, se figur 2, till styripulsgeneratorn 28 och omkopplingslogiken 18 blir negativ vilket innebär nedstyrning och därmed polaritetsändring av bryggan 1, jfr. fig 3a. Tidsintervallet för nedstyrningen, t₂ - t₁ enligt figur 3b, från maximalt positiv toppspänning till maximalt negativ toppspänning är approximativt lika med 8,3 ms vid en frekvens av 50 Hz och 6-puls 2-vägsbrygga.

Vid tidpunkten t₃, varvid strömmen I_{FB1} fortfarande är större än 0, ges dels tändpuls till urladdningstyristorn 10 och dels blockeringssignal till bryggan 1. På grund av fröhjulsverkan vid negativ utstyrning åstadkoms en momentan överföring av matningsströmmen I_{FB1} till överspänningsskyddskretsen och bryggan 1 blir strömlös. Vid signal för strömlös brygga 1 från mätdonet 24 initieras dels deblockering av brygga 2 och dels blockering av tändkretsen 14 för tyristorn 10. Tidsintervallet t₄ - t₃ enligt figur 3, dvs. tiden från blockering av bryggan 1 tills bryggan 2 inkopplas är approximativt lika med 5 ms, se figur 3. Av figur 3d framgår att strömmen I_F i fältkretsen 4 under detta växlingsintervall upprätthålls till följd av fältlindningens 4 induktans. Som framgår av figur 3d och e driver den uppstyrda bryggan 2 nu dels

en ström I_R , se fig. 3f, genom tyristorn 10 och strömbegränsningsmotståndet R och dels en ström I_F genom synkronmaskinens fältlindning 4. Vid tidpunkten t_5 har fältströmmen I_F ändrat polaritet och urladdningstyristorn 10 släckts genom temporär nedstyrning av bryggan 2, dvs. temporär polaritetsändring för att driva en ström i

5 kortslutningskretsens eller överspänningsskyddets backriktning.

Genom lämpliga val av strömnivåer för generering av blockering och detekteringssignaler blir tidsintervallet för inkoppling av det som hjälpkrets tjänande dubbelriktade fältöverspänningsskyddet 8, 10, 12, 14 eller dubbelriktade tyristorurladdningskretsen kortvarig.

10 Växling från negativ strömriktning till positiv strömriktning vid positiv styrsignal sker på motsvarande sätt genom temporär inkoppling av tyristorn 8 i överspänningsskyddet.

Ovan har ett utföringsexempel av den roterande elektriska maskinen enligt uppfinningen beskrivits men ett flertal modifikationer är självfallet tänkbara inom

15 uppfinningens ram. Sålunda kan den beskrivna principen användas för såväl stillastående som roterande tyristorbryggor för magnetisering av synkronmaskiner eller matning av motorer för drivsystem. Vidare kan temporär eller pulsad nedstyrning utnyttjas för återställning av ett aktiverat överspänningsskydd. En överspänningssignal ger då i ett första skede signal för larm och återställning av skyddet. En kontinuerlig felsignal efter ett antal återställningsförsök alstrar en utlösningssignal.

20

Dessutom kan införandet och användandet av släckbara halvledarelement förkorta tidsintervallet för växling mellan positiv och negativ magnetisering eller vice versa. Införandet av släckbara halvledarelement i det dubbelriktade överspänningsskyddet innebär att temporär teckenvändning av fältspänningen ej behövs för att

25 släcka ett aktiverat och ledande halvledarelement.

PATENTKRAV

1. Roterande elektrisk maskin av växelströmstyp, avsedd att direkt anslutas till ett distributions- eller transmissionsnät och innefattande minst en elektrisk lindning,
5 **kännetecknad av** att lindningen innefattar minst en elektrisk ledare, ett ledaren omslutande första skikt med halvledande egenskaper, ett det första skiktet omslutande fast isolerande skikt och ett det isolerande skiktet omslutande andra skikt med halvledande egenskaper samt att ett borstlöst, mellan positiv och negativ magnetisering växlingsbart magnetiseringssystem är inrättat för maskinens magnetisering.
- 10 2. Maskin enligt krav 1, **kännetecknad av** att potentialen på det första skiktet är väsentligen lika med potentialen på ledaren.
3. Maskin enligt krav 1 eller 2, **kännetecknad av** att det andra skiktet är an-
15 ordnat att bilda väsentligen en ekvipotentialyta, omgivande ledaren.
4. Maskin enligt krav 3, **kännetecknad av** att det andra skiktet är anslutet till en förutbestämd potential.
- 20 5. Maskin enligt krav 4, **kännetecknad av** att nämnda förutbestämda potential är jordpotential.
6. Maskin enligt något av föregående krav, **kännetecknad av** att åtminstone två närbelägna skikt hos maskinens lindning har väsentligen lika stora värmeutvidg-
25 ningskoefficienter.
7. Maskin enligt något av föregående krav, **kännetecknad av** att ledaren innefattar ett antal kardeler, av vilka åtminstone några är i elektrisk kontakt med varandra.
- 30 8. Maskin enligt något av föregående krav, **kännetecknad av** att vart och ett av nämnda tre skikt är fast förbundet med närbelägna skikt längs väsentligen hela anliggningsytan.

9. Maskin enligt något av föregående krav, **kännetecknad** av att nämnda skikt är anordnade att vidhäfta varandra även då den isolerade ledaren böjs.
10. Maskin innefattande minst en elektrisk huvudmaskin av växelströmstyp, avsedd att direkt anslutas till ett distributions- eller transmissionsnät och innefattande en magnetisk kärna och minst en elektrisk lindning, **kännetecknad** av att lindningen är bildad av en kabel innefattande en eller flera strömförande ledare, varvid varje ledare uppvisar ett antal kardeler, ett inre halvledande skikt anordnat runt varje ledare, ett isolerande skikt av fast isolationsmaterial anordnat runt nämnda inre halvledande skikt, och ett yttre halvledande skikt, anordnat runt det isolerande skiktet, samt att ett borstlöst, mellan positiv och negativ magnetisering växlingsbart magnetiseringssystem är inrättat för maskinens magnetisering.
11. Maskin enligt krav 10, **kännetecknad** av att nämnda kabel innefattar en metallskärm eller mantel.
12. Maskin enligt något av föregående krav, **kännetecknad** av att magnetiseringssystemet innefattar två styrbara antiparallellkopplade strömriktaranordningar för matning av växelströmsmaskinens fältlindning (4), ett dubbelriktat fältöverspänningsskydd (8,10,12,14) eller urladdningskrets inkopplad över fältlindningen samt styrutrustning för styrning av strömriktare och fältöverspänningsskydd eller urladdningskrets.
13. Maskin enligt krav 12, **kännetecknad** av att för växling av magnetströmriktningen från magnetiseringssystemet är styrutrustningen anordnad att ändra polariteten på strömriktarna, varvid styrutrustningen styr överspänningsskyddet att temporärt inkopplas vid övergång från den ena till den andra strömriktningen.
14. Maskin enligt krav 12 eller 13, **kännetecknad** av att överspänningsskyddet eller urladdningskretsen innefattar en dubbelriktad tyristorurladdningskrets (8, 10).

15. Maskin enligt något av patentkraven 12 - 14, **kännetecknad av** att aktiverat överspänningsskydd eller urladdningskrets är återställbar genom styrning av ledande strömriktaranordningar (1, 2) till temporär eller pulsformad polaritetsändring.
- 5 16. Maskin enligt något av patentkraven 12 - 14, **kännetecknad av** att aktiverat överspänningsskydd eller urladdningskrets är återställbar genom släckbara halvledarelement.
- 10 17. Elkraftanläggning, **kännetecknad av** att den innefattar en roterande elektrisk maskin enligt något av kraven 1 - 16.
- 15 18. Förfarande för magnetisering av en roterande elektrisk maskin med såväl positiv som negativ magnetiseringsströmriktning, **kännetecknat av** att ett dubbelriktat överspänningsskydd (8,10,12,14) eller en dubbelriktad urladdningskrets inkopplas temporärt över maskinens fältlindning (4) vid växling mellan magnetiseringsströmriktningarna.
-

SAMMANDRAG

En roterande elektrisk maskin av växelströmstyp är avsedd att direkt anslutas till ett distributions- eller transmissionsnät och innefattar minst en elektrisk lindning. Lindningen innefattar minst en elektrisk ledare, ett ledaren omslutande första skikt med halvledande egenskaper, ett det första skiktet omslutande fast isolerande skikt och ett det isolerande skiktet omslutande andra skikt med halvledande egenskaper. Ett borstlöst, mellan positiv och negativ magnetisering växlingsbart magnetiseringssystem är vidare inrättat för maskinens magnetisering. En elkraftanläggning innefattar en sådan roterande elektrisk maskin. Vid ett förfarande för magnetisering av en roterande elektrisk maskin med såväl positiv som negativ magnetiseringsströmriktning inkopplas ett dubbelriktat överspänningsskydd (8, 10, 12, 14) eller en dubbelriktad urladdningskrets temporärt över maskinens fältlindning (4).

15

(Fig. 2)

Fig. 1

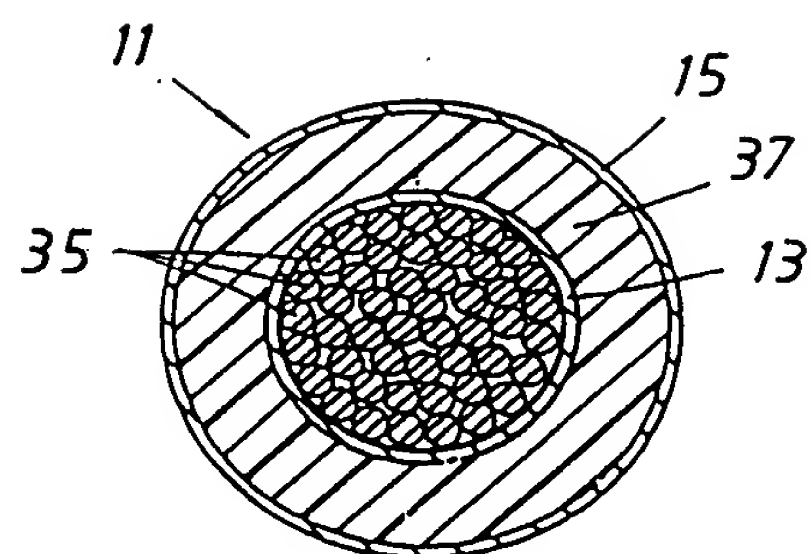
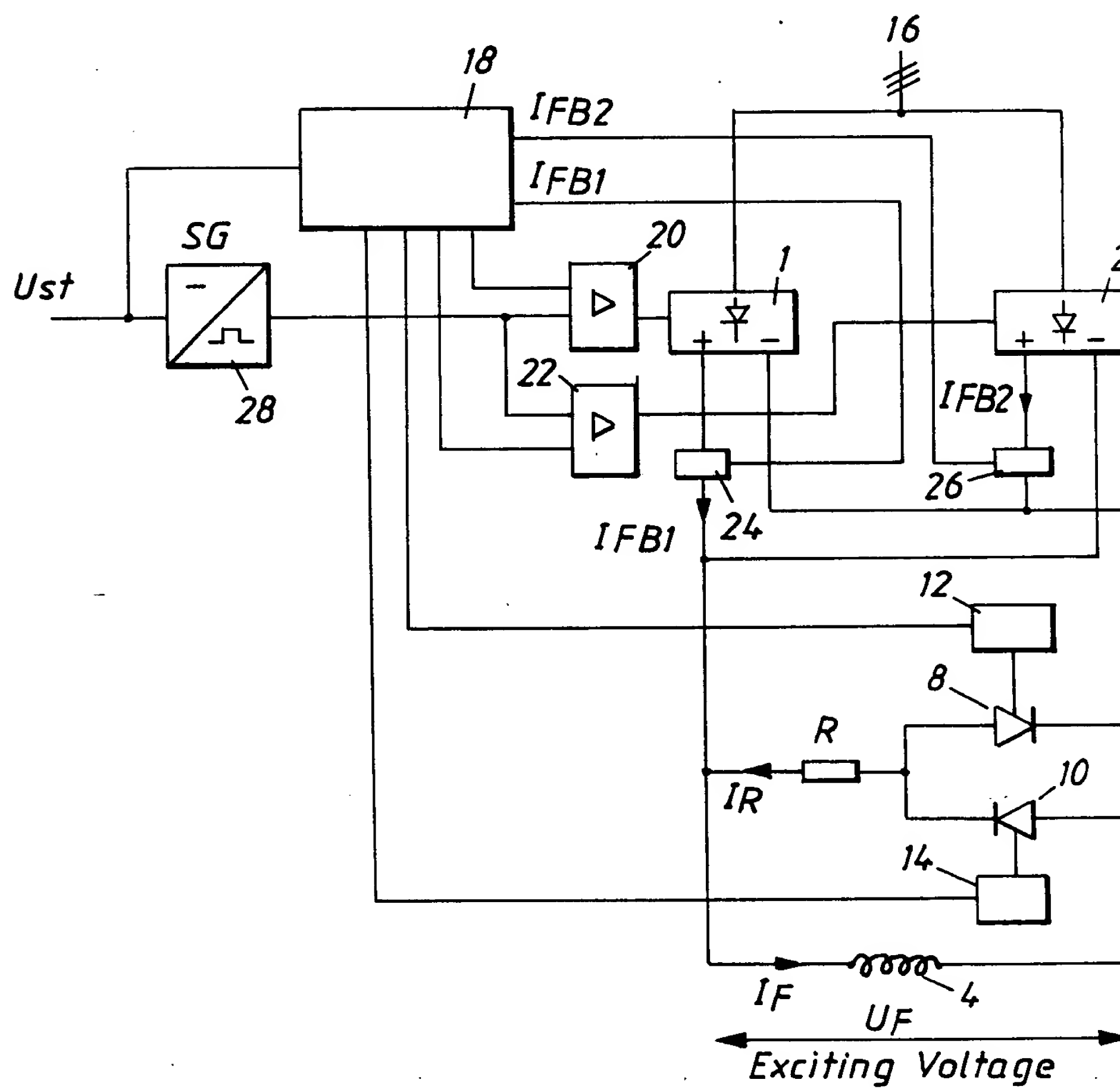


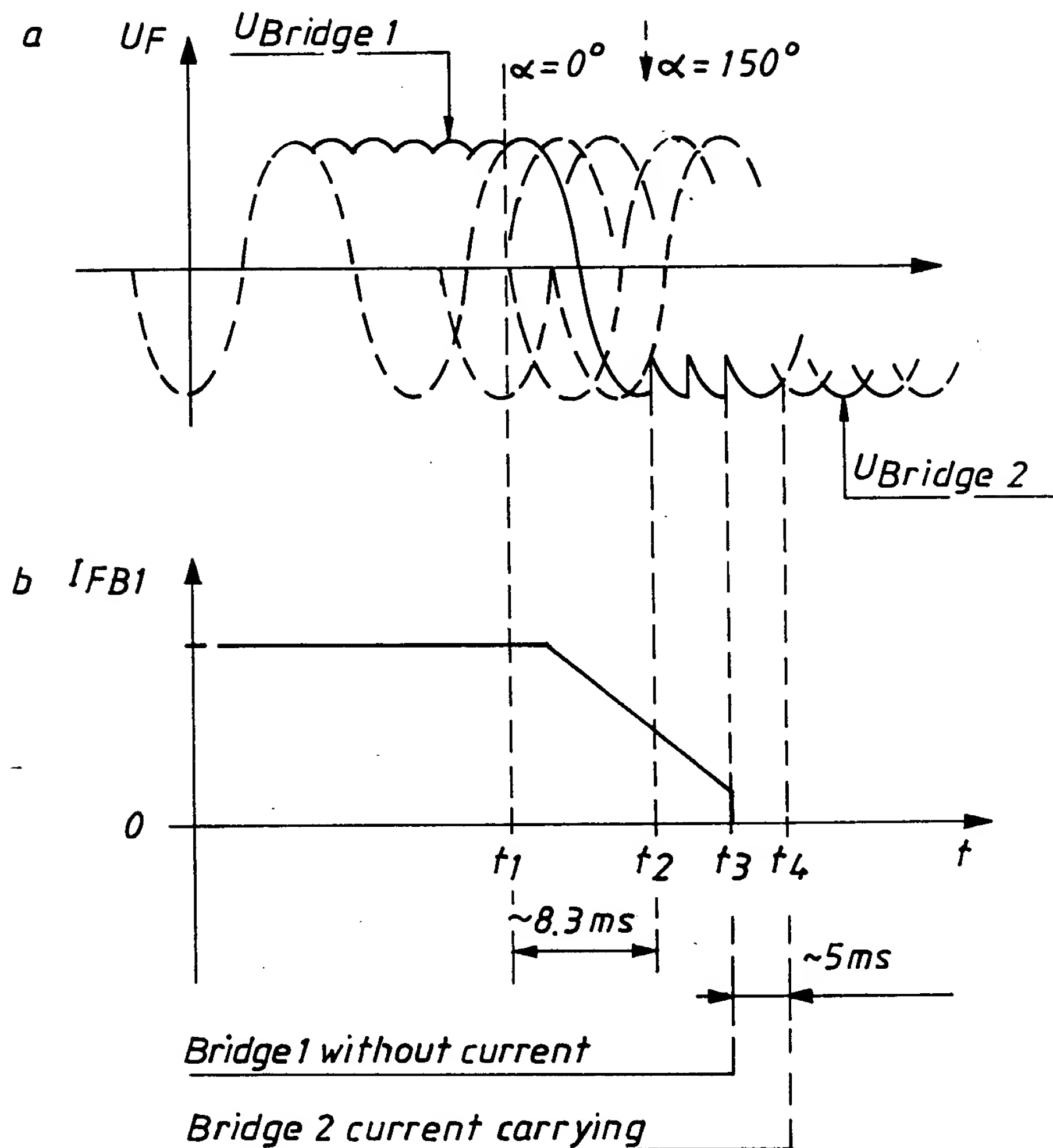
Fig. 2



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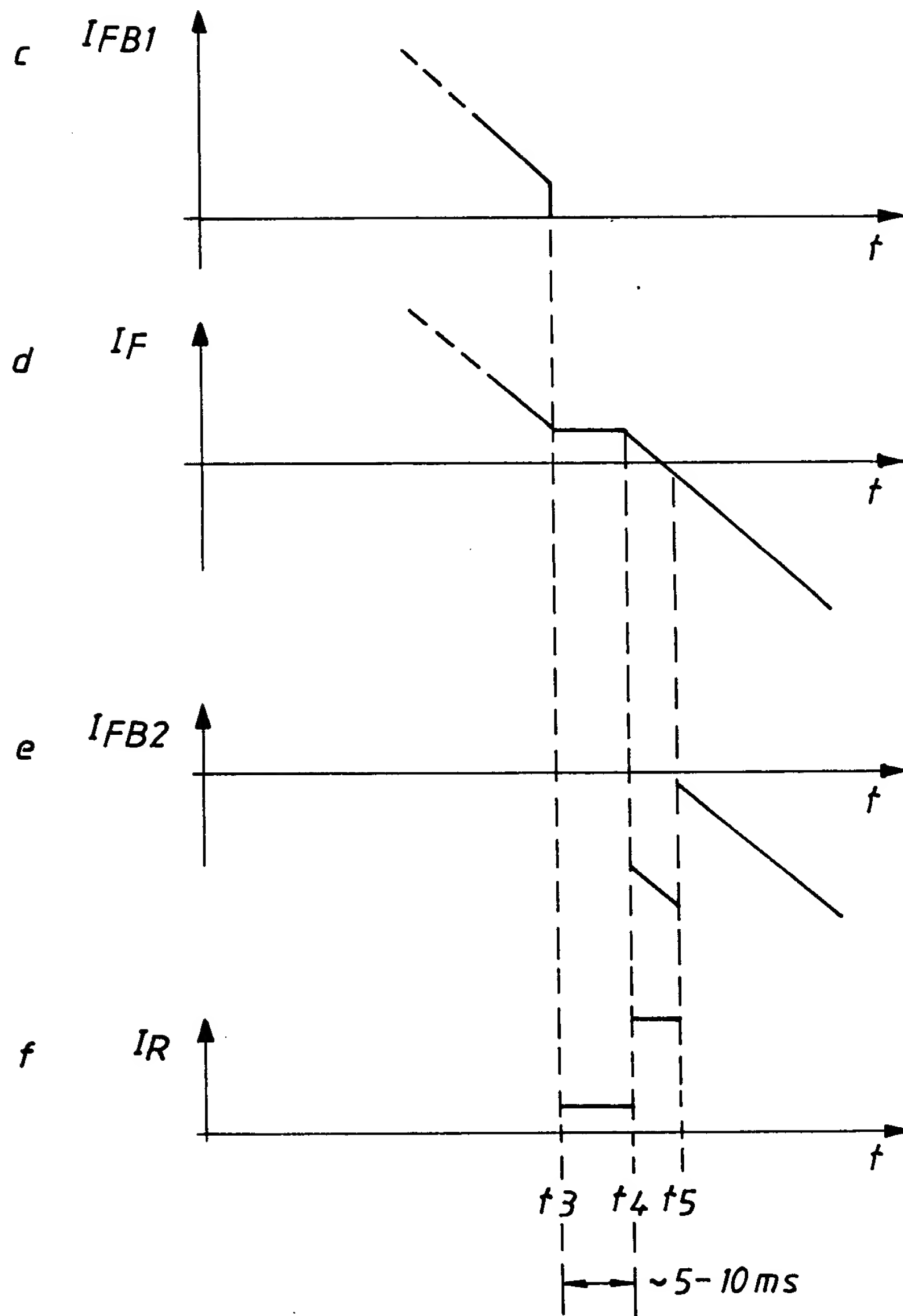
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Fig. 3**SUBSTITUTE SHEET**

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Fig. 3 (contd.)**SUBSTITUTE SHEET**



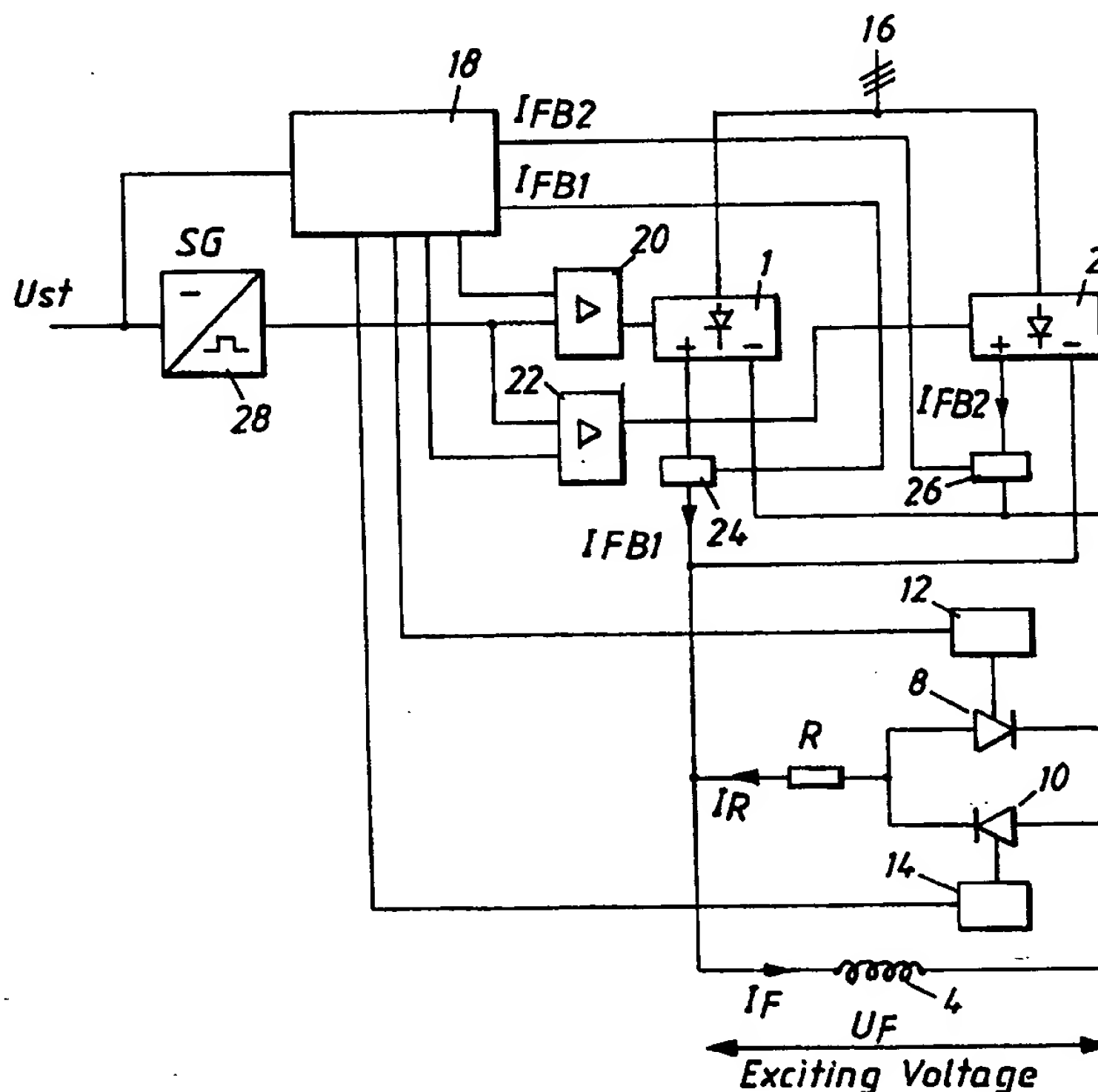
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(51) International Patent Classification ⁶ : H02K 19/26, 19/36		A1	(11) International Publication Number: WO 99/17432
			(43) International Publication Date: 8 April 1999 (08.04.99)
(21) International Application Number: PCT/SE98/01741 (22) International Filing Date: 29 September 1998 (29.09.98) (30) Priority Data: 9703555-4 30 September 1997 (30.09.97) SE (71) Applicant (for all designated States except US): ASEA BROWN BOVERI AB [SE/SE]; S-721 83 Västerås (SE). (72) Inventors; and (75) Inventors/Applicants (for US only): SÖRENSEN, Erland [SE/SE]; Gudruns väg 32, S-723 55 Västerås (SE). LEIJON, Mats [SE/SE]; Hyvlargatan 5, S-723 35 Västerås (SE). (74) Agent: HOPFGARTEN, Nils; L.A. Groth & Co. KB, P.O. Box 6107, S-102 32 Stockholm (SE).		(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), EE, ES, FI, FI (Utility model), GB, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG). Published With international search report. In English translation (filed in Swedish).	

(54) Title: A ROTARY ELECTRIC MACHINE

(57) Abstract

A rotary electric machine of alternating current type designed to be connected directly to a distribution or transmission network comprises at least one electric winding. The winding comprises at least one electric conductor, a first layer with semi-conducting properties surrounding the conductor, a solid insulating layer surrounding the first layer and a second layer with semi-conducting properties surrounding the insulating layer. A brushless excitation system, switchable between positive and negative excitation, is also arranged for excitation of the machine. An electric power plant comprises such a rotary electric machine. In a method of exciting a rotary electric machine with both positive and negative excitation current direction, a two-way field over-voltage protection means (8, 10, 12, 14) or a two-way discharge circuit is connected temporarily across the field winding (4) of the machine.



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INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 98/01741

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H02K 19/26, H02K 19/36

According to International Patent Classification (IPC) or to both national classification and IPC

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4785138 A (O. BREITENBACK ET AL.), 15 November 1988 (15.11.88), see the whole document --	1-18
Y	US 4121148 A (H. PLATZER), 17 October 1978 (17.10.78), see the whole document --	1-18
Y	US 4106069 A (J. TRAUTNER ET AL.), 8 August 1978 (08.08.78), see the whole document --	1-18
Y	DE 3009102 A1 (PROIZVODSTVENNOE OBEDINENIE URALELEKTROTJASCHMASCH IMENI V.I. LENINA), 25 Sept 1980 (25.09.80), see the whole document --	12-18

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Date of the actual completion of the international search

18 December 1998

Date of mailing of the international search report

13 -01- 1999

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INTERNATIONAL SEARCH REPORT

International application No.

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